

**INDIANA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS MANAGEMENT**

**DETERMINATION OF INTELLIGENT COMPACTION
MEASUREMENT VALUE OF SOIL
ITM No. 513-14T**

1.0 SCOPE

- 1.1** This method of test covers the procedure for determining the target Intelligent Compaction Measurement Value (IC-MV) of a soil. The number of passes of the roller(s) to obtain the IC-MV at the required moisture content range of the soil is also determined.
- 1.2** The target IC-MV is required to be monitored to verify changes in the soil or the roller response as lifts of the soil progress or conditions change. New test sections may be required when these changes occur.
- 1.3** This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the ITM. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

T 99 Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

2.2 ITM Standards.

ITM 506	Field Determination of moisture Content of Soils
ITM 509	Field Determination of Strength Using Dynamic Cone Penetrometer
ITM 512	Field Determination of Maximum Dry Density and Optimum Moisture Content of Soil

3.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101 and as follows:

- 3.1** Construction Area. Subsections of the contract being compacted continuously by the Contractor that are used to evaluate the soil stiffness for acceptance

- 3.2** Global Positioning System (GPS). A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. For this application, GPS is referred to all GPS-related signals including US GPS and other Global Navigation Satellite Systems (GNSS).
- 3.3** GPS Base Station. A single ground-based system that consists of a GPS receiver, GPS antenna, radio, and radio antenna to provide L1/L2 differential GPS correction signals to other GPS receivers within a range limited by radio, typically 3 miles in radius without repeaters.
- 3.4** GPS Rover. A hand-held GPS radio/receiver for in-situ point measurements
- 3.5** Intelligent Compaction (IC). A process, using accelerometer or Machine Drive Power (MDP) technology, that is equipped with a compaction measurement and documentation system that automatically records various critical compaction parameters in real time during the compaction process. IC uses roller compaction measurements to assess the mechanistic soil properties and to ensure optimum compaction is achieved through continuous monitoring of the operations
- 3.6** Intelligent Compaction Measurement Value (IC-MV). The output from the IC roller that represents the stiffness of the soil based on the rolling resistance or vibration of the roller drums and the resulting response from the underlying materials.
- 3.7** Intelligent Compaction (IC) Roller. A self-propelled static or vibratory roller equipped with machine drive power and/or with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted soil to evaluate the applied compaction effort. IC rollers may be configured in various combinations to include smooth or pad foot drums, static or vibratory, and accelerometer or MPD.
- 3.8** Mapping. The process of rolling the Construction Area with the IC roller to determine the IC-MV
- 4.0** **SIGNIFICANCE AND USE.** This ITM shall be used to determine the target IC-MV of a soil that corresponds with the target DCP measurement at the required moisture content range. The number of passes of the roller(s) to achieve the target IC-MV is determined. Control of compaction of the soil may be made by monitoring the stiffness using the IC-MV.

5.0 APPARATUS.

- 5.1** IC Roller, meeting the requirements of Section 3.7
- 5.2** DCP, meeting the requirements of ITM 509
- 5.3** Moisture content equipment, meeting the requirements of ITM 506
- 5.4** GPS equipment, meeting the requirements of Sections 3.1, 3.2, and 3.3

6.0 GEOMETRICS OF A TEST SECTION. The test section shall be approximately 225 ft long and 24 ft wide and be constructed in a construction area. For IC accelerometer type rollers, the initial test section shall be mapped after approximately 2 ft of embankment has been placed. For IC MDP type rollers, the initial test section shall be mapped after 1 ft of embankment has been placed. To determine the target IC-MV, a construction area of 10000 ft² to 75000 ft² shall be used.

7.0 TEST SECTION PREPARATION.

- 7.1** The natural ground surface shall be proofrolled in accordance with 203.26 prior to construction of the test section lift.
- 7.2** The soil in the test section shall meet the requirements of 203.09 and 203.23.
- 7.3** The DCP and moisture requirements for the classification of soil being compacted shall be verified in accordance with ITM 512 on the first lift of the embankment.
- 7.4** The DCP and moisture acceptance tests on each underlying lift of the 1 ft or 2 ft layer construction area will meet the specification requirements.
- 7.5** The moisture acceptance tests on the top lift of the 1 ft or 2 ft layer construction area will meet the specification requirements.
- 7.6** The roller shall be checked to assure that the equipment complies with the specification requirements. The speed of the roller and the frequency of vibratory rollers shall be consistent throughout the test section. There shall be no stopping or turning within the established test section.
- 7.7** The boundaries of the test section shall be determined by the GPS rover and visually identified for the IC Roller Operator and Technicians that are testing the test section.

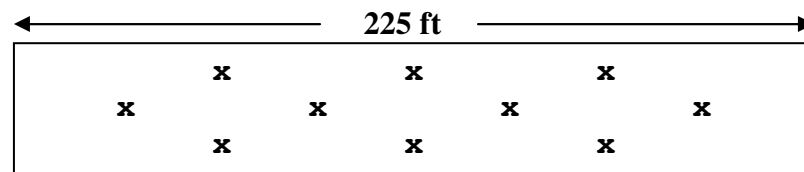
8.0 PROCEDURE – NUMBER OF ROLLER PASSES

- 8.1** Initially roll the top lift of the test section with up to four applications of the compaction roller.

Note 1: A roller application is defined as one pass of the roller over the entire test section.

Note 2: The roller that is used for normal production compaction shall be used for the test section. This may be the IC roller or a different roller as designated in the Quality Control Plan.

- 8.2** Following the initial applications with the compaction roller, obtain 10 random DCP tests spaced uniformly throughout the test section at the following locations. Each location shall be marked with paint.



- 8.3** Average the 10 DCP test values
- 8.4** Apply one additional application with the compaction roller
- 8.5** Test the same 10 random locations 1 ft from each original test site with the DCP and average the test results
- 8.6** Add one additional application of the compaction roller until the average of the 10 DCP test values meets the required DCP blow count for the type of soil being compacted. Each additional DCP test shall be taken 1 ft from any previous test site.
- 8.7** Prepare the test section for mapping with one or more passes of a smooth drum roller or grader to provide a smooth surface for the IC mapping. If pad footed rollers were used for the compaction of the test section and IC pad footed rollers are used for mapping, this additional preparation is not required.
- 8.8** Zero the roller data and printer and verify this equipment is ready to function
- 8.9** Map the test section and print the data from the IC roller
- 8.10** Report the initial target IC-MV value by recording the average IC-MV from the printout

9.0 PROCEDURE – TARGET IC-MV

- 9.1** Set the initial target IC-MV in the IC roller
- 9.2** Compact a construction area of 10000 ft² to 75000 ft²
- 9.3** Verify that the DCP and moisture acceptance tests on each lift of the 1 ft or 2 ft layer construction area meet the specification requirements
- 9.4** Prepare the construction area with one or more passes of a smooth drum roller or grader to provide a smooth surface for the IC mapping. If pad footed rollers were used for compaction and IC pad footed rollers are used for mapping, this additional preparation is not required.
- 9.5** Zero the roller data and printer and verify this equipment is ready to function
- 9.6** Set the printer to identify at least three deficient areas
- 9.7** Map the construction area with the IC roller
- 9.8** Print the data from the roller and identify the deficient areas from the printout and operators screen
- 9.9** Select three deficient areas with the lowest IC-MV for further investigation with the DCP
- 9.10** Test each of the deficient areas with the DCP and locate one boundary for each of the three deficient areas. A boundary is a location where the DCP test results transition from failing to passing tests.
- 9.11** Identify each boundary with paint
- 9.12** Correlate the boundary limits with the IC roller information screen and drive the roller to the boundary of the first deficient area
- 9.13** Compare the red area on the IC roller screen to the location of the roller icon on the screen.
 - 9.13.1** If the red boundary matches the location of the roller, the target IC-MV is tentatively correct.
 - 9.13.2** If the red boundary does not match the location of the roller, adjust the target IC-MV on the IC roller screen until the boundary correlates with the roller location at the edge of the deficient area. Increasing the target IC-MV enlarges the red area and decreasing the target IC-MV reduces the red area.

9.13.3 Record the tentative target IC-MV for the first deficient area

- 9.14** Drive the roller to the boundaries of the second and third deficient areas and repeat step 9.13. Additional deficient areas may be tested if there is an inconsistency in the test results from the three deficient areas. A minimum of three representative deficient areas are required to determine the final target IC-MV.
- 9.15** Average the target IC-MV numbers obtained from the three deficient areas to determine the final target IC-MV for that type of soil.
- 9.16** Set the target IC-MV in the roller software and print the report for the mapped area

10.0 REPORT.

- 10.1** The information from the test section to include the date, location, number of passes to achieve the target DCP, DCP test data for the initial passes and each additional pass of the roller, and the type of roller used to compact the test section shall be reported.
- 10.2** The target IC-MV shall be reported.